WBS 6.5: Phase II Muon Upgrade

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Scope of the Muon Upgrade for ATLAS

- To cope with high rates, the readout of the MDT system will be replaced, as well as the barrel (RPC) and end-cap (TGC) triggering system

- To reduce fakes

  - p_T selectivity of tracks for the trigger will be improved by integrating MDT information into the L1 trigger

  - new sTGC's will be installed in the inner ring of the big wheel to reduce fakes at high η ($2 < |\eta| < 2.4$)

- To extend system lifetime

  - Gas gain in RPC's will be lowered to meet design limitations (0.3 C/cm^2), and new RPC's will be installed in the inner layer of the barrel to maintain trigger efficiency and increase acceptance

  - HV and LV power supplies will be replaced to ensure operation of the muon spectrometer at the HL-LHC through 2035

Next ➤ US ATLAS Scope

Scope for US-ATLAS

- To cope with high rates, the readout of the MDT system will be replaced

- To reduce fakes

  - p_T selectivity of tracks for the trigger will be improved by integrating MDT information into the L1 trigger

Arguably the most important part of the upgrade

US will replace the MDT readout electronics

Next ➤ MDT Electronics for Phase II

The MDT Readout Electronics for Phase II

Component	Function	Interested Institutions
Mezzanine Card	Front-end board for the ASD and TDC	Arizona BostonU
ASD Chip Amplifier, Shaper, Discriminator	Amplifies, shapes, discriminates incoming MDT signals	BNL/Michigan
TDC Chip Time to Digital Converter	Performs the drift time measurement for the MDT	BNL/Michigan BostonU
CSM Chamber Service Module	Broadcasts timing and control signals to the TDC, and collects data from the mezzanine for readout	Michigan
Hit Extraction Board	Receives, buffers, processes (event building) data from the MDT front-end, and interfaces with trigger/DAQ systems	Illinois (UIUC)
MDT Trigger Processor	MDT precision hit information must be integrated into Level-1 trigger	UCIrvine

Next ➤ Costs and WBS

The MDT Readout Electronics for Phase II

- **From "Open" Phase II Muon Meeting:** Interested institutions required to submit an R&D proposal to myself and L2 R&D manager (Anyes Taffard), due first week of August
- All institutions below have submitted proposals outlining desired R&D/Construction activities and most have submitted estimated construction costs (So far, I have only studied the calculated CSM costs in detail)
- L3 WBS items will correspond to a single deliverable component, and hopefully a single responsible institution ➤ L4 deliverables will then be prototypes v1, v2, and final production

Component	Function	Interested Institutions	WBS	Labor Costs (k$)	Construction Costs (k$)
Mezzanine Card	**Front-end board for the ASD and TDC**	**Arizona BostonU**	**6.5.1**	**685**	**2858**
ASD Chip Amplifier, Shaper, Discriminator	**Amplifies, shapes, discriminates incoming MDT signals**	**BNL/Michigan**	**6.5.2**	**1627**	**897**
TDC Chip Time to Digital Converter	**Performs the drift time measurement for the MDT**	**BNL/Michigan BostonU**			
CSM Chamber Service Module	**Broadcasts timing and control signals to the TDC, and collects data from the mezzanine for readout**	**Michigan**	**6.5.3**	**1838**	**1380**
Hit Extraction Board	**Receives, buffers, processes (event building) data from the MDT front-end, and interfaces with trigger/DAQ systems**	**Illinois (UIUC)**	**6.5.4**	**1354**	**525**
MDT Trigger Processor	**MDT precision hit information must be integrated into Level-1 trigger**	**UCIrvine**	**6.5.5**		
			Total Costs	**5504 k$**	**5660 k$**

From Scoping Document

Table 25. Top-level summary of the CORE cost estimates for the Phase-II ATLAS upgrades by detector subsystems (expanded to Level-2 in the WBS).

WBS	Detector system	Reference Detector Total Cost [MCHF]	Middle Scenario Differential Cost [MHCF]	Low Scenario Differential Cost [MCHF]
	ATLAS	**271.04**	**-42.55**	**-71.16**
1.	TDAQ	43.31	-11.41	-18.19
1.1	L0 Central Trigger	1.21	-	-
1.2	L0 Calorimeter Trigger	0.70	-	-0.24
1.3	L0 End-cap Muon	2.56	-0.11	-0.11
1.4	L0 Barrel Muon	1.32	-0.14	-0.17
1.5	L1 Central Trigger	1.93	-	-
1.6	L1 Global Trigger	3.39	-	-
1.7	L1 Track	4.19	-0.67	-2.49
1.8	FTK++	13.03	-4.88	-9.56
1.9	DAQ/Event Filter	14.98	-5.62	-5.62
2.	ITk	120.36	-7.2	-23.6
2.1	Pixel	32.19	-0.9	-4.8
2.2	Strip	72.10	-6.3	-18.8
2.3	Common Items	16.08	-	-
3.	LAr	45.98	-13.60	-13.60
3.1	Read-out electronics	31.39	-	-
3.2	sFCal	10.03	-10.03	-10.03
3.3	HGTD	4.56	-4.56	-4.56
3.4	LAr MiniFCal		*+0.91*	
3.5	Si-based MiniFCal		*+3.57*	
4.	Tile	8.58	-	-
5.	Muon	34.08	-8.78	-12.79
5.1	MDT	7.69	-2.07	-3.16
5.2	RPC	7.99	-2.32	-4.79
5.3	TGC	4.44	-	-
5.4	High-Eta Tagger	3.50	-3.50	-3.50
5.5	Power System	10.47	-0.89	-1.34
6.	Forward	1.30	-	-
7.	Integration & Installation	17.42	-1.56	-2.98

US Core Cost Fraction for Muons	16%	22%	26%

Using 5660k$ from previous table

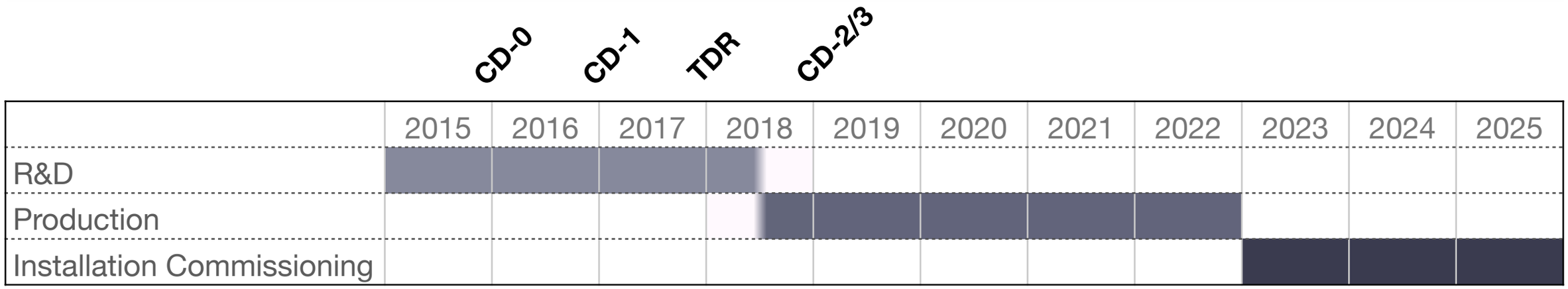
Question - do materials & prototypes count as core costs?

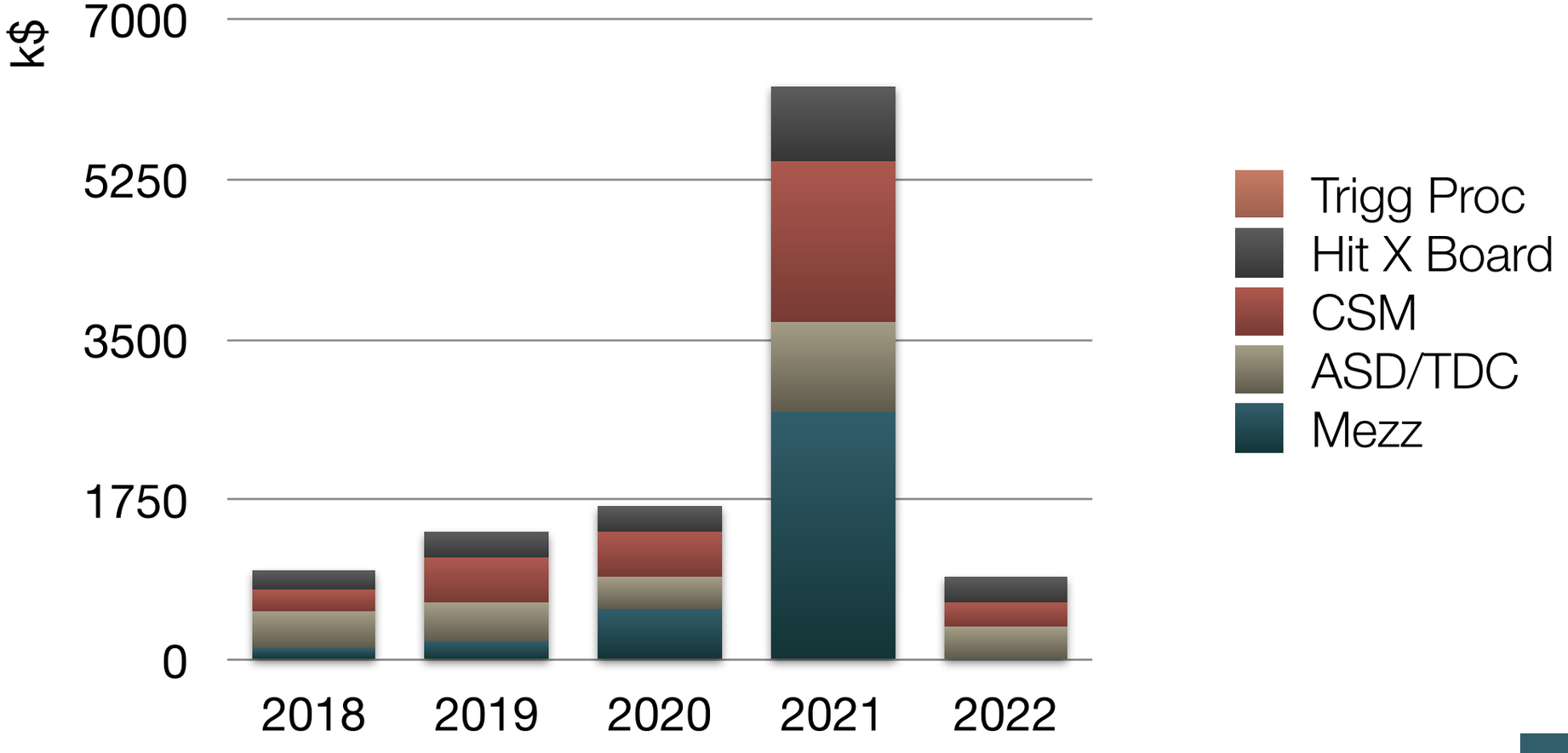
WBS

6.5.2	**TDC/ASD**
6.5.2.1	**TDC/ASD v1**
TDC2101	Specifications
TDC2102	Design and Firmware Simulation
TDC2103	Chip Layout and Simulation
TDC2104	Fabrication
TDC2105	Packaging
TDC2106	Testing
6.5.2.2	**TDC/ASD v2**
TDC2201	Design and Firmware Simulation
TDC2202	Chip Layout and Simulation
TDC2203	Fabrication
TDC2204	Packaging
TDC2205	Testing
6.5.2.3	**TDC/ASD Final**
TDC2301	Fabrication and Assembly
TDC2302	Test Fixture Design/Testing
TDC2303	Testing

Next ➤ Schedule

Schedule





Next ➤ Tasks for CD-0

Muon Level-2 To-Do's for CD-0

- ~~Define scope for US Muons~~
- ~~Determine institutes who want to be involved~~
- ~~Define R&D and rough construction plans for deliverables~~

We are here

- Determine (and check) costs and schedule
- Fraction of core-costs (we are in ballpark of 20%) but need to get more detailed core costs for our projects
- Prioritize projects under budget scenarios

End